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having been abandoned and much new material with numerous figures having been added. There is a change of view in regard to leaf arrangement, and alternation of generations receives some attention. Naturally the relation between form and function, the inheritance of malformations, and the significance of juvenile stages are of interest to all botanists, and whether one agrees with the author or not, GOEBEL's account is stimulating and should put a needful restraint upon those who would blindly assign every such phenomenon to heredity and recapitulation.

The intimation, in the preface, that botanists have left the older fields of morphology needs a word of comment, for there are still some of us who feel as much interest in the problems of evolution, heredity, and phylogeny, as in seeing "the wheels go round." We welcome this book as a wholesome check. The morphologist whose principal interest is in phylogeny needs it, just as the experimental morphologist, whose principal interest is in something other than phylogeny, needs to know more about the structure and development of the objects upon which he is experimenting.

The second volume, dealing with special organography and containing the index, will be awaited with interest.—CHARLES J. CHAMBERLAIN.

## NOTES FOR STUDENTS

**Osmotic pressures.**—RENNER<sup>3</sup> has rendered a very important service to plant physiology by summarizing and subjecting to a critical analysis the literature of recent years dealing with the methods of calculating the osmotic pressure of solutions. All methods heretofore used by physiologists have been based on the assumption that an osmotic pressure of 22.4 atmospheres at 0° C. produces a freezing temperature of -1.85° C. But this depression of the freezing point, according to the physicists, is brought about when a mole of a non-electrolyte is dissolved in 1000 cc. of water; whereas physiologists have always made up their solutions as weight per cent solutions, or as molecular solutions in which enough water is used to make 1000 cc. of solution, but still assuming that the osmotic pressure of these more concentrated solutions is 22.4 atmospheres for undissociated salts. The discussion centers about the work of MORSE, FRAZER, and their co-workers, whose exact determinations have now shown clearly that such solutions must be made up in weight normal instead of volume normal concentrations in order to yield osmotic pressures agreeing with the gas laws. RENNER shows from calculations based upon the determinations of MORSE that there is a very close relation between depression of the freezing point and osmotic pressure. He claims indeed that all the disagreements in the literature between the results of the cryoscopic and plasmolytic determinations of osmotic pressure are traceable to the fact that the

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<sup>3</sup> RENNER, O., Über die Berechnung des osmotischen Druckes. Biol. Centralbl. 32:486-504. 1912.

freezing point method uses weight normal, whereas the plasmolytic method uses volume normal solutions. He shows conclusively in his discussion that it is the plasmolytic method which has been in error.

The large error of the old method is illustrated by the cryoscopic measurement of a volume normal cane sugar solution. The depression of the freezing point is  $-2.66^{\circ}\text{C.}$ , which indicates an osmotic pressure of 32 atmospheres instead of 22.4 atmospheres. The excess pressure is due to the sugar being dissolved in less than 1000 cc. of water. A comparison of the pressures for 67 per cent cane sugar and 18.5 per cent NaCl as calculated from the volume normal and weight normal concentrations is very illuminating also. The NaCl solution contains 3.6 moles of salt, 50 per cent ionized, in a liter of solution; while the sugar solution contains only 2.6 moles, with no ionizing, per liter. The NaCl should develop a much higher pressure according to the plasmolytic method of estimating pressures; but adopting the method of MORSE, now shown to be correct, which demands equal quantities of solvent, we find that the NaCl is dissolved in 928 cc., the sugar in only 439 cc. of water. The relations of the two solutions are seen to be actually the reverse of what the plasmolytic method indicates. Owing to the dissociation of the NaCl, the solutions are really nearly isosmotic. These examples serve to show the unreliability of the plasmolytic determinations with volume normal solutions, and the necessity, despite their inconvenience, of using weight normal solutions in the future.

It is unfortunate that the physical chemists have not determined the osmotic pressure of saturated solutions by the cryoscopic method. While RENNER makes clear that at the concentrations thus far measured the freezing point determinations will give the correct osmotic pressure, it remains to be demonstrated that this holds for all concentrations whatsoever. The direct determinations by Lord BERKELEY and HARTLEY for concentrated sugar solutions exceed the measurements called for even by the MORSE-FRAZER method. At present, the reviewer believes that these direct measurements, recently confirmed by TROUTON, are the most trustworthy determinations we have for concentrated solutions. If the cryoscopic methods should yield results in agreement with the direct measurements at these same concentrations, and with saturated solutions of various salts, its universal application could be admitted. If it does not, then still further correction of the formula for calculating the osmotic pressure of solutions must be made. Every physiologist interested in the determination of osmotic pressures should by all means read RENNER's excellent discussion.—CHARLES A. SHULL.

**Paleobotanical notes.**—ARBER<sup>4</sup> has described 44 species of plants from a coal-field in Gloucestershire, none of which are new to Great Britain. The

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<sup>4</sup> ARBER, E. A. NEWELL, On the fossil flora of the Forest of Dean coal-field (Gloucestershire), and the relationships of the coal-fields of the west of England and South Wales. *Phil. Trans. Roy. Soc. London B* 202:233-281. *pls. 11-13.* 1912.